Nutrient Transport from White Creek and Tappen Creek into Tappen Bay

Introduction

Located in the Southern Interior of British Columbia (BC), Shuswap Lake is an important waterbody in the territory of the Pespesellkwe te Secwepemc. The lake provides critical fish habitat for a diverse community of aquatic life, is a regional drinking water source, and supports a thriving recreation and tourism industry. The increased frequency of algal blooms in the Salmon Arm of Shuswap Lake has highlighted the need to determine potential sources of nutrients. To understand nutrient transport from tributaries to Tappen Bay, located within the Salmon Arm, the BC Ministry of Environment and Parks (ENV) collected water quality samples from White Creek and Tappen Creek from 2010 to 2012. The following summary discusses available nutrient data from this period and provides recommendations for future water quality monitoring.

Site Description

White Creek begins above White Lake, flowing approximately 25 km through both White Lake and Little White Lake, before travelling south into Shuswap Lake at Tappen Bay. Apart from the residential community of White Lake and Trans-Canada Highway 1, land use within the White Creek watershed is predominantly agricultural (Figure 1).

The headwaters of Tappen Creek are located near the base of Mount Tappen and the creek flows southeast for approximately 6.5 km before entering Shuswap Lake. The Tappen Creek watershed is less developed than the White Creek watershed and includes sections of agricultural and range lands (Figure 1).

Assessment Methods

Water quality data collected from 2010 to 2012 for White Creek and Tappen Creek were retrieved from the provincial Environmental Monitoring System (ENV, 2025). Monitoring was completed at White Creek EMS site 0500098 and at Tappen Creek EMS site 0600246, both located near Tappen Bay and Trans-Canada Highway 1. Assessment of the available data focused on the following parameters:

- Nitrogen species: total nitrogen, nitrate plus nitrite, and total Kjeldahl nitrogen; and,
- Phosphorus species: total phosphorus and orthophosphate.

To provide additional context with respect to potential water quality impacts, nutrient concentrations were compared to the current BC Approved Water Quality Guidelines, as applicable (BC Ministry of Water, Land, and Resource Stewardship (WLRS), 2025). When reported concentrations were below the method detection limit, the method detection limit concentration was used for the analysis. As creek flow data and field observation records were not available, Shuswap Lake water level data for the collection period (i.e., from 2010 to 2012) were used as a proxy to understand freshet timing and seasonal nutrient transport (City of Salmon Arm, 2025).

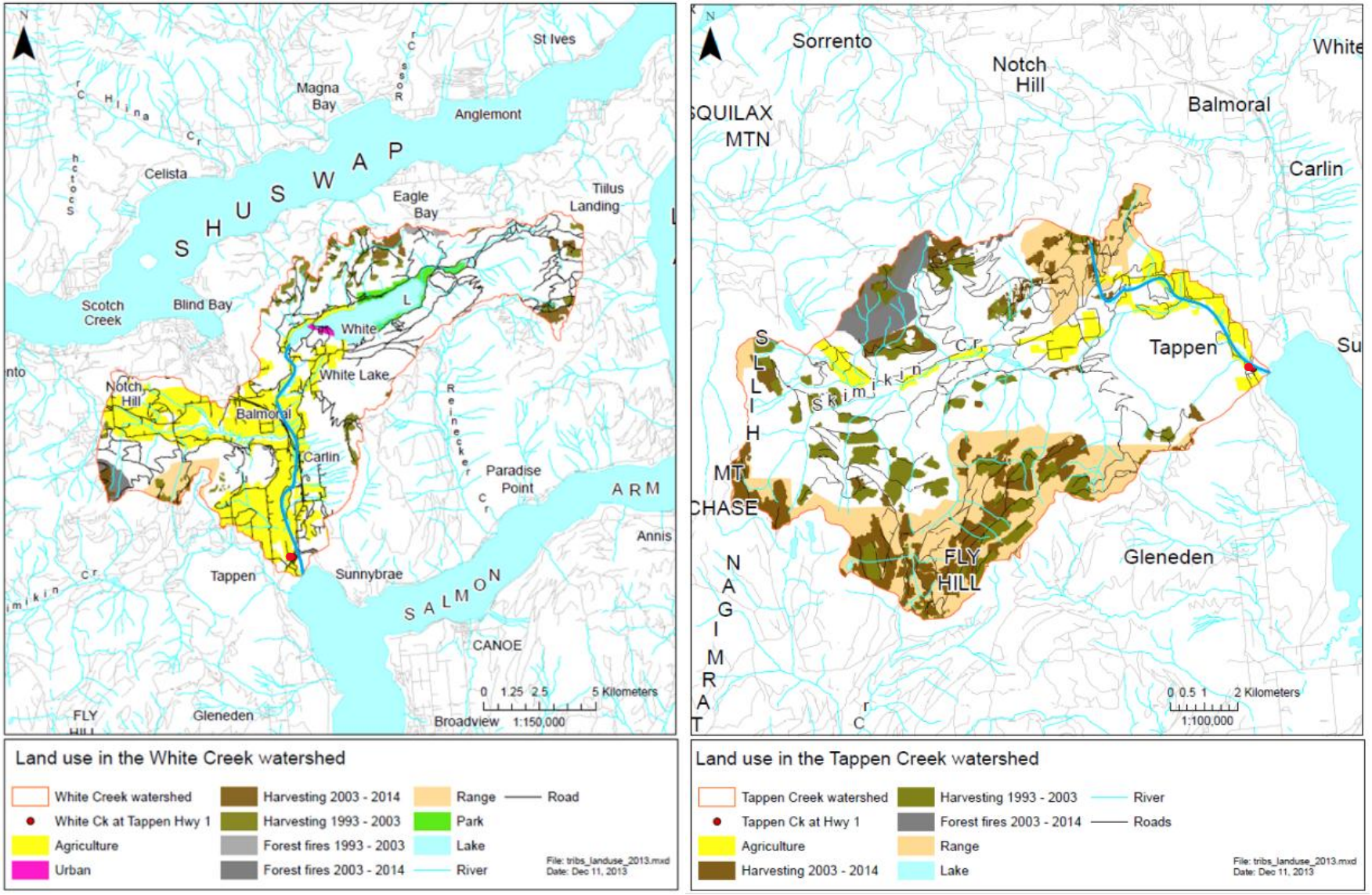

Figure 1. *Land use in the White Creek and Tappen Creek watersheds (2013). The approximate path of each creek has been highlighted with a darker blue line, with red dots indicating sample sites.*

Results

Nitrogen Species

Total Nitrogen

Total nitrogen concentrations in both tributaries exhibited seasonal variability during the 2010-2012 monitoring period, with concentrations increasing during freshet, prior to seasonal lake level peaks (Figure 2). White Creek total nitrogen levels were consistently higher than Tappen Creek, with average concentrations of 1.19 mg/L and 0.29 mg/L, respectively.

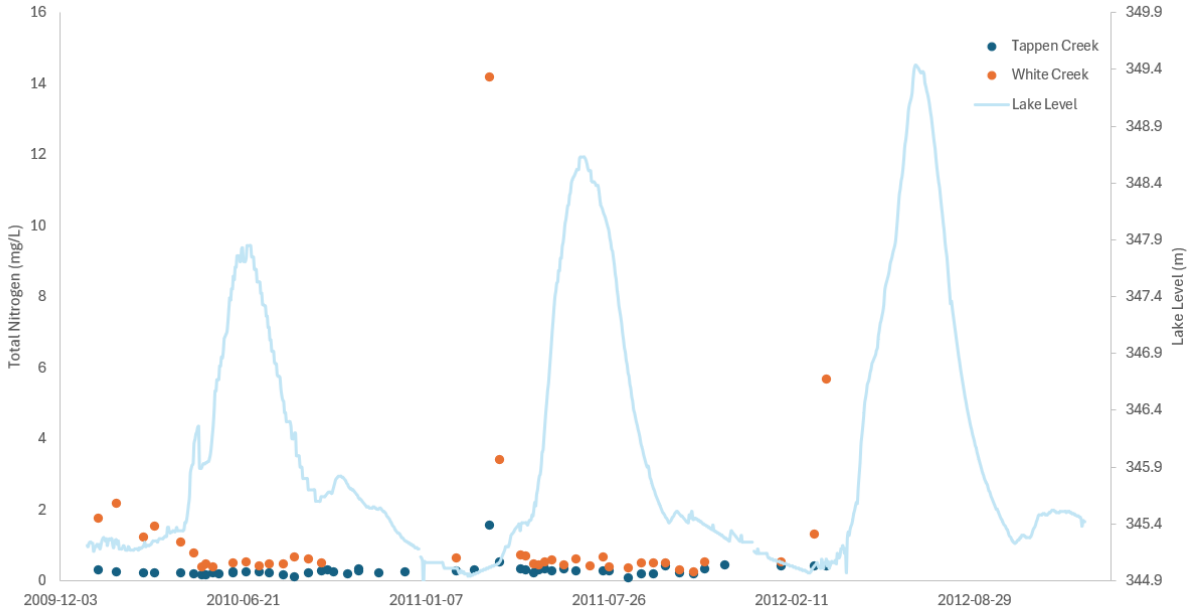

Figure 2. *Total nitrogen concentrations in White (EMS ID 0500098) and Tappen (EMS ID 0600246) creeks from 2010-2012, relative to Shuswap Lake water levels.*

Nitrate Plus Nitrite

Due to complex chemical reactions in water, nitrate and nitrite are often combined during laboratory analysis into nitrate plus nitrite. The average nitrate plus nitrite concentration in White Creek was 0.69 mg/L, which was higher than the concentration in Tappen Creek of 0.18 mg/L.

Increased concentrations of nitrate plus nitrite corresponded with freshet, just prior to lake level increases (Figure 3). At White Creek, nitrate plus nitrite contributed to approximately 37% of the total nitrogen, in contrast to Tappen Creek, where nitrate plus nitrite was the predominant form of nitrogen (61%).

While there are no BCWQG for nitrate plus nitrite as a combined value, there are separate guidelines for nitrate and nitrite (WLRS, 2025). The most stringent BCWQG for nitrate for the protection of long-term chronic effects to freshwater aquatic life is 3.0 mg/L. Based on the average concentrations for both creeks, this guideline was met during the monitoring period, assuming that the combined result mainly consisted of nitrate. Nitrite guidelines vary depending on the total chloride concentration (WLRS, 2025). As total chloride data are unavailable, comparison to the appropriate guideline cannot be completed.

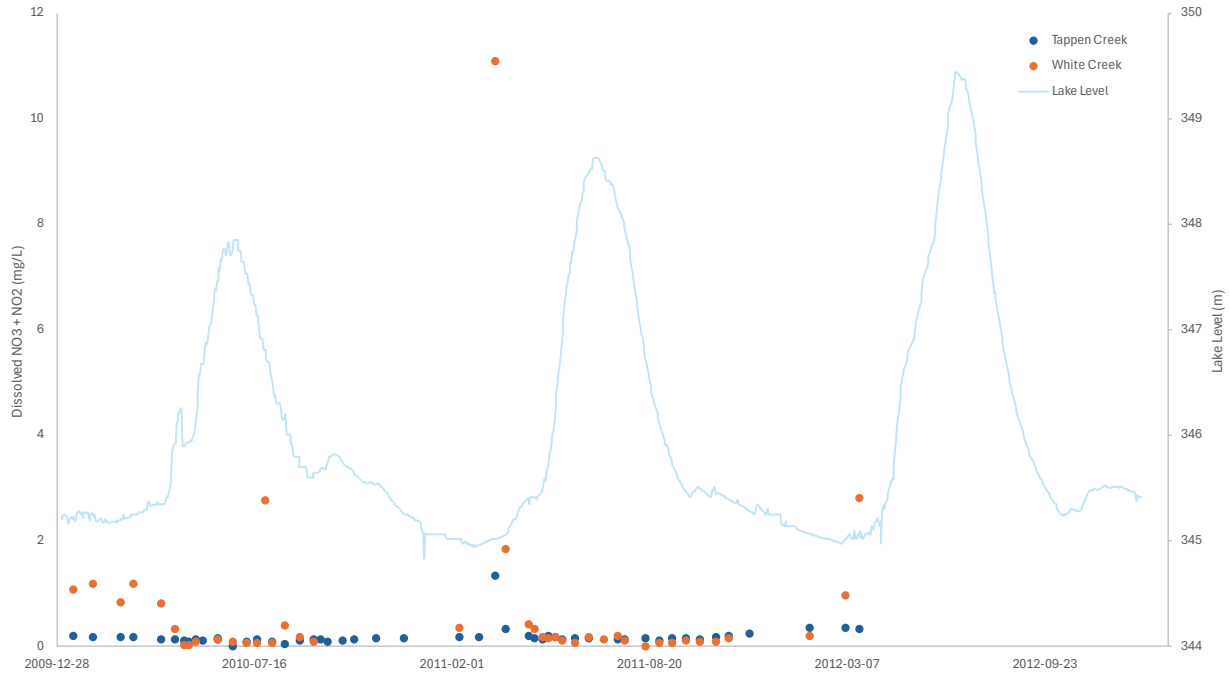

Figure 3. *Nitrate plus nitrite concentrations in White (EMS ID 0500098) and Tappen (EMS ID 0600246) creeks from 2010-2012, relative to Shuswap Lake water levels.*

Total Kjeldahl Nitrogen

Total Kjeldahl nitrogen is the sum of both organic nitrogen and ammonia. Average total Kjeldahl nitrogen concentrations for White and Tappen creeks from 2010 to 2012 were 0.54 mg/L and 0.11 mg/L, respectively. Following the trends of the other nitrogen species, concentrations were higher in White Creek and increased just prior to lake level increases (Figure 4). Of note, total Kjeldahl nitrogen contributed to approximately 45% of the total nitrogen in White Creek, with approximately 38% total Kjeldahl nitrogen at Tappen Creek.

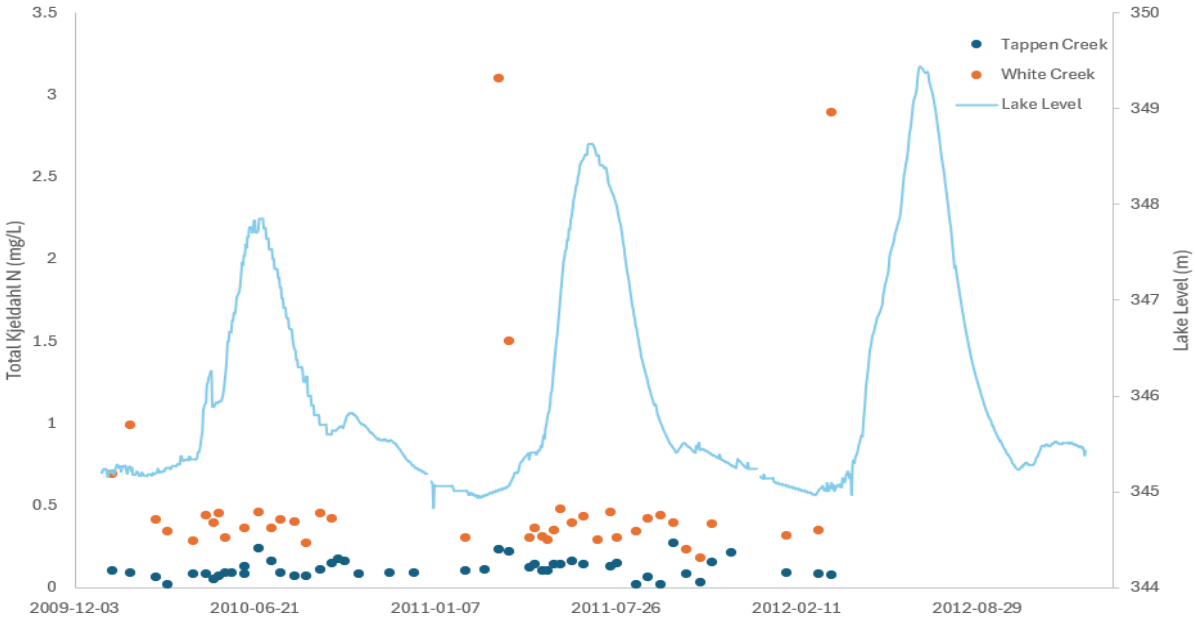

Figure 4. *Total Kjeldahl nitrogen concentrations in White (EMS ID 0500098) and Tappen (EMS ID 0600246) creeks from 2010-2012, relative to Shuswap Lake water levels.*

Phosphorus Species

Total Phosphorus

Total phosphorus concentrations showed similar trends to nitrogen species, with higher concentrations in White Creek compared to Tappen Creek, and concentrations increasing during freshet (Figure 5). Average total phosphorus concentrations in White and Tappen creeks from 2010 to 2012 were 0.08 mg/L and 0.02 mg/L, respectively. There are no BCWQG specifically available for total phosphorus in streams; instead, the guideline focuses on the growth of periphytic algae, measured as chlorophyll a (WLRS, 2025). There are no chlorophyll a data available for this dataset and thus, no direct guideline comparison can be completed.

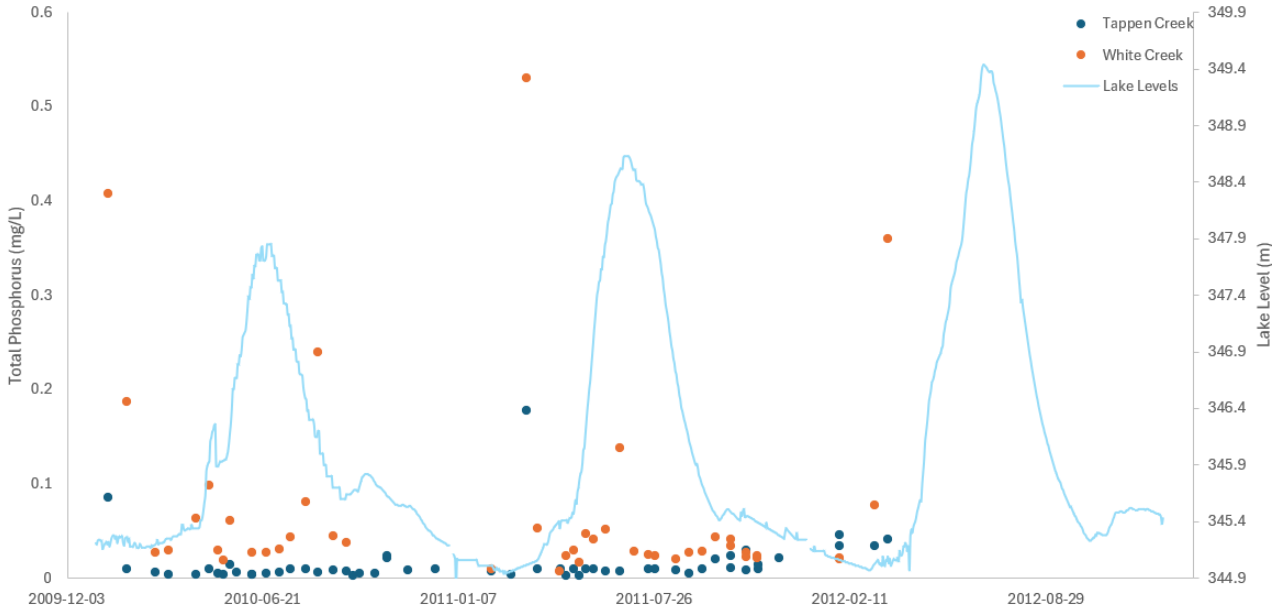

Figure 5. *Total phosphorus concentrations in White (EMS ID 0500098) and Tappen (EMS ID 0600246) creeks from 2010-2012, relative to Shuswap Lake water levels.*

Orthophosphate

Orthophosphate is the phosphorus species that is biologically available for algal growth. The average orthophosphate concentration in White Creek was 0.04 mg/L, which was higher than the orthophosphate concentration for Tappen Creek of 0.01 mg/L (Figure 6). Of the total phosphorus concentration at White Creek approximately 44% was orthophosphate, with 43% at Tappen Creek, indicating that almost half of the total phosphorus was available for uptake by algae or other aquatic plant life. Similar to the total phosphorus concentrations, orthophosphate concentrations followed a seasonal trend in both creeks, with increases during freshet (Figure 6). There are no specific BCWQG available for orthophosphate (WLRS, 2025).

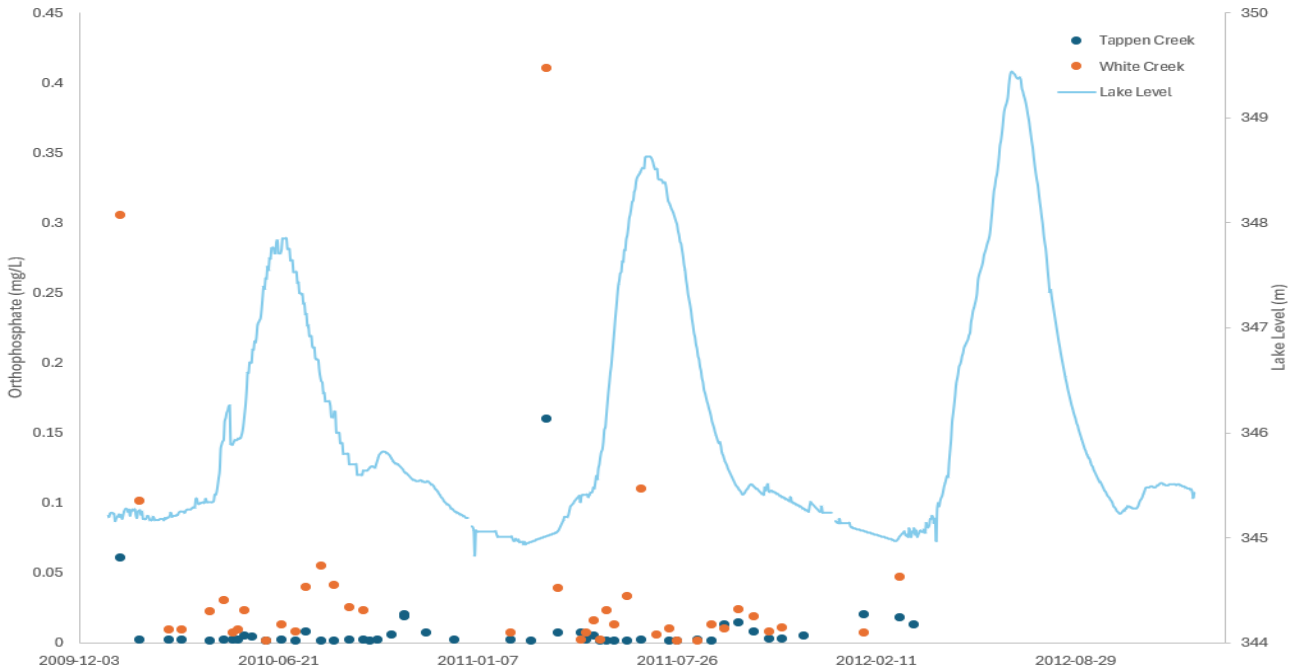

Figure 6. *Orthophosphate concentrations in White (EMS ID 0500098) and Tappen (EMS ID 0600246) creeks from 2010-2012, relative to Shuswap Lake water levels.*

Discussion

The frequency of algal blooms in the Tappen Bay area of Shuswap Lake has increased over the years, with nutrient concentrations of primary concern. Data collected by ENV from two tributaries, White Creek and Tappen Creek, were analyzed to assess potential nutrient transport from the creeks into Tappen Bay.

Nutrient concentrations in both creeks exhibited seasonal variability, with increases corresponding with freshet timing. Seasonal nutrient increases during freshet are consistent with typical watershed dynamics for the area as snowmelt conveys runoff into streams and higher flows flush nutrients from throughout the watershed into receiving waters.

Nutrient levels were consistently higher in White Creek when compared to Tappen Creek. The higher nutrient concentrations in White Creek are likely attributed to the land use within the watershed, including the residential community of White Lake and agricultural activities throughout its length. The land use influence is further reflected in higher levels of organic nitrogen in White Creek in comparison to Tappen Creek. In its upper reaches, White Creek flows through both White Lake and Little White Lake, which also may have influenced downstream water quality. In contrast, the Tappen Creek watershed is less developed, which appears to have resulted in the lower nutrient concentrations measured in the creek.

Both nitrogen and phosphorus are essential nutrients for algal growth. Like most freshwater lakes, Shuswap Lake is phosphorus-limited, meaning that minor inputs of phosphorus, particularly in its biologically available form (as orthophosphate), can lead to increased algal growth. In both creeks, orthophosphate contributed to almost half of the total phosphorus measured, indicating potential for the stimulation of algal growth.

While nutrient availability is a key driver, there are several factors that can lead to algal blooms, including temperature, light penetration, and water column stability. Climate change is exacerbating circumstances, with increased temperatures, longer growing seasons, and changes to precipitation patterns generating more favourable conditions for algal blooms to occur, especially in a shallow, protected area like Tappen Bay.

Conclusions

To understand nutrient transport from White and Tappen creeks to Tappen Bay, ENV conducted water quality monitoring during 2010 to 2012. Review of the available nutrient data associated with this monitoring program indicated the following:

- Nutrient concentrations were highest in the creeks in the spring prior to lake level rise, which is typical for the freshet period, as surface runoff flushes nutrients from across the watershed into streams. Nutrient transport is likely to continue to follow this seasonal trend.
- Nutrient concentrations were consistently higher in White Creek compared to Tappen Creek, which was expected as White Creek has a more developed watershed in comparison to that of Tappen Creek, including greater residential and agricultural land use.
- There were no recorded instances when nutrient concentrations were above applicable BCWQG.

Recommendations

Future monitoring may contribute to a more current and thorough understanding of nutrient transport from both creeks, especially if significant land use changes occur within the watersheds. The following could be considered:

- Develop a field sampling program with sufficient frequency to capture peak nutrient concentrations (e.g., 5 sampling events over 30 days during freshet).
- Prioritize White Creek if sampling constraints arise, given its higher nutrient concentrations and greater land use influence.

Additionally, the relative sizes and nutrient contributions of the creeks should be evaluated when planning future monitoring given other key nutrient sources to the Salmon Arm, such as the local wastewater treatment plant discharge and inputs from the Salmon River.

References

City of Salmon Arm. 2025. Shuswap Lake Level History. Accessed October 29, 2024 from: https://www.salmonarm.ca/DocumentCenter/View/240/Shuswap-Lake-Level-History?bidId=

B.C. Ministry of Environment and Parks (ENV). 2025. Surface Water Quality Monitoring Sites. Accessed November 1, 2024 from: https://governmentofbc.maps.arcgis.com/apps/webappviewer/index.html?id=0ecd608e27ec45cd923bdcfeefba00a7

B.C. Ministry of Water, Land, and Resource Stewardship (WLRS). 2025. British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture - Guideline Summary. Water Quality Guideline Series, WQG-20. Prov. B.C., Victoria B.C.